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Title: CartaBlanca-Rapid Prototyping Development Environment for Non-Linear Systems on Unstructured Grids

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CartaBlanca- Rapid Prototyping Development Environment for Non-linear Systems on Unstructured Grids

Abstract

This talk describes a component-based nonlinear physical system simulation prototyping package written entirely in Java using object-oriented design. The package provides scientists and engineers a "developer-friendly" software environment for large-scale computational algorithm and physical model development. The software design centers on the Jacobian-Free Newton-Krylov solution method surrounding a finite-volume treatment of conservation equations. This enables a clean component-like implementation. We first provide motivation for the development of the software and then discuss software structure. Discussion includes a description of the use of Java's built-in thread facility that enables parallel, shared-memory computations on a wide variety of unstructured grids with triangular, quadrilateral, tetrahedral and hexahedral elements. We also discuss the use of Java's inheritance mechanism in the construction of a hierarchy of physics systems objects and linear and nonlinear solver objects that simplify development and foster software re-use. Following this, we show results from example calculations and then discuss plans including the extension of the software to distributed memory computer systems.

Objectives

- *Developer-friendly* rapid proto-typing tool.
- OO Java + Jacobian-Free Newton-Krylov + finite volume method
  => non-linear solver environment.
- Multiphase flow on unstructured grids for complex multi-material applications.
- Explore Java's thread facility and DSM's for parallel computations.

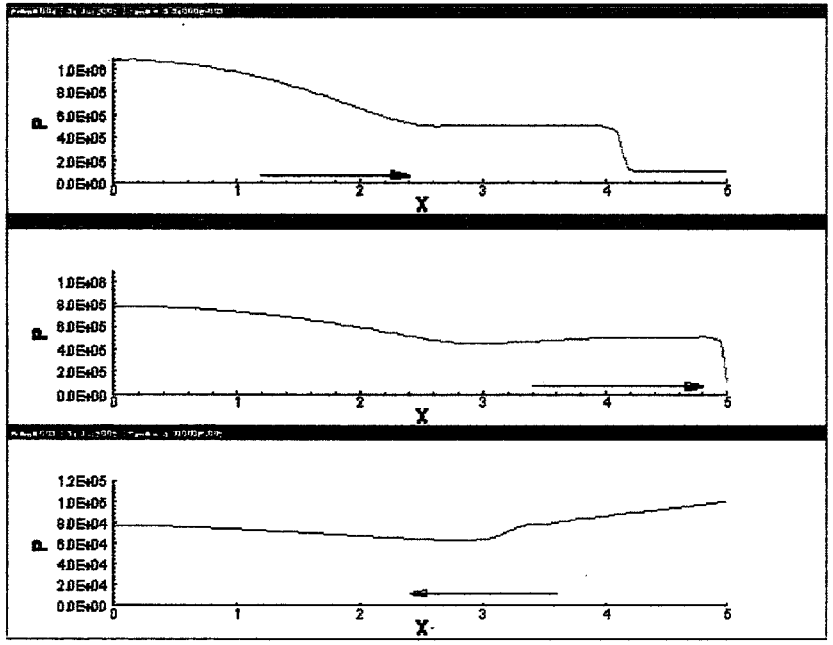
Why Java?

- Type-safe
- Safe memory model
- Object oriented programming
- Portable
- Large marketplace presence
- Many reusable components available
- Built-in threads for parallel, DSM's, …

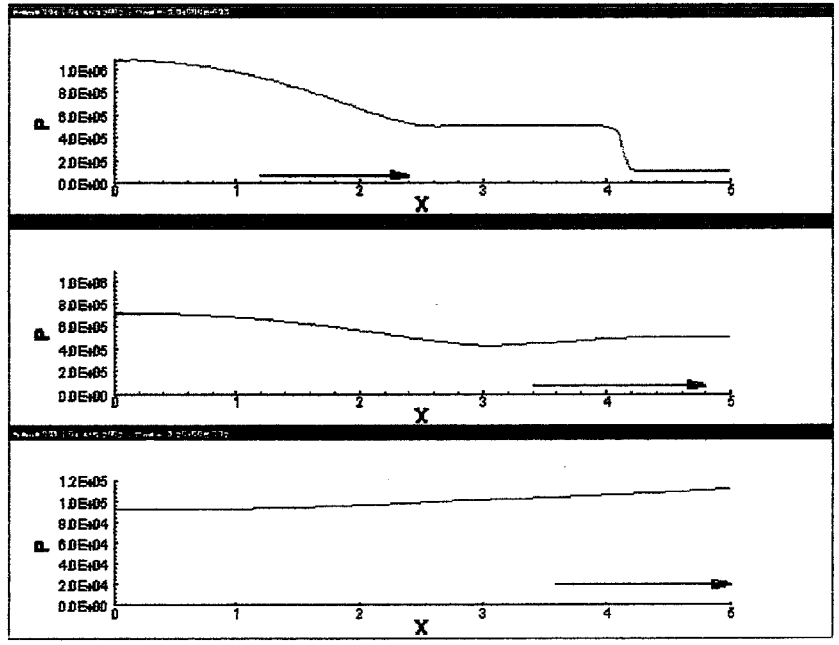
Compressible Flow

- Mach 3 Pressure wave.
- Effect of BC treatment.

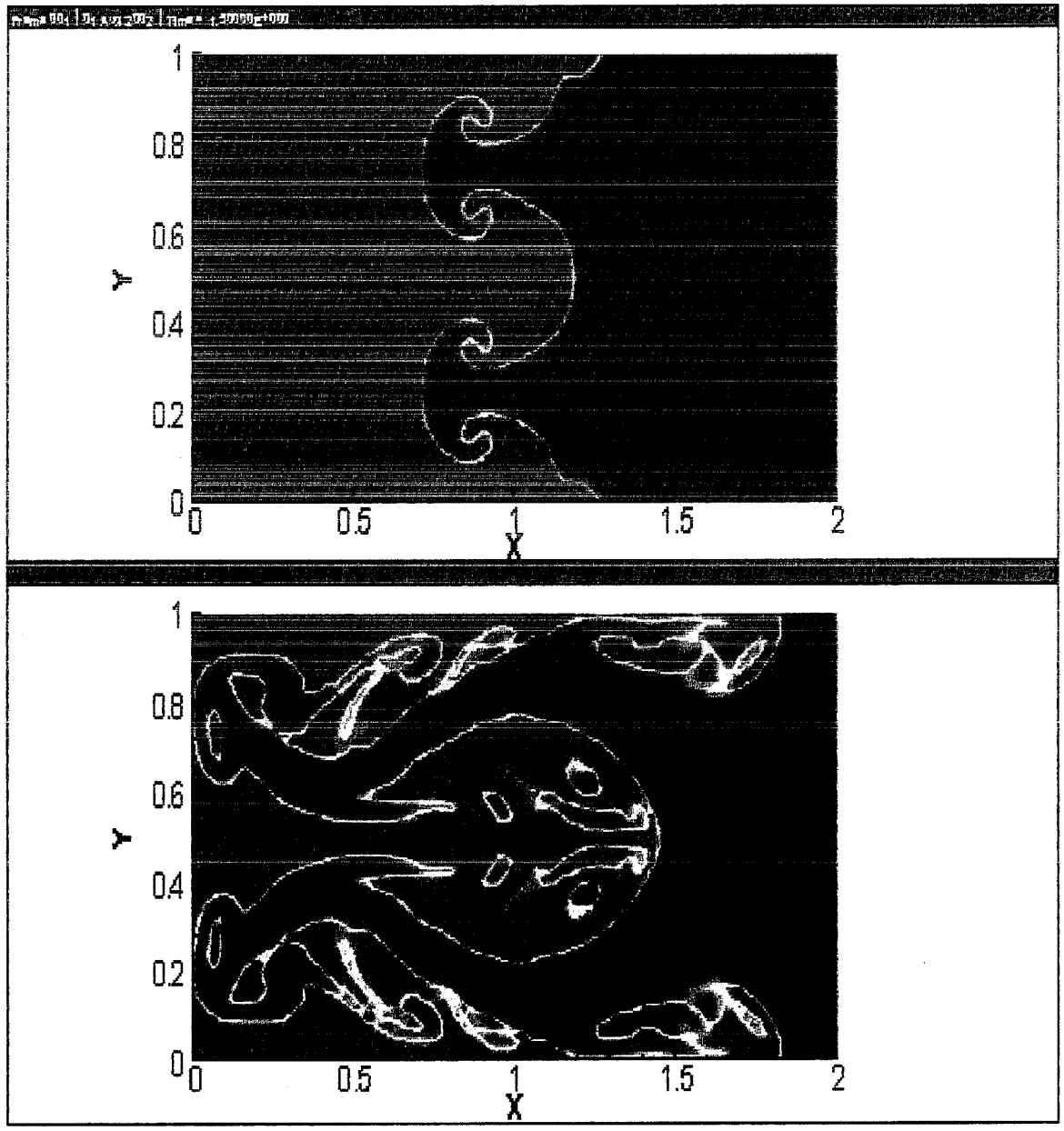
Constant pressure



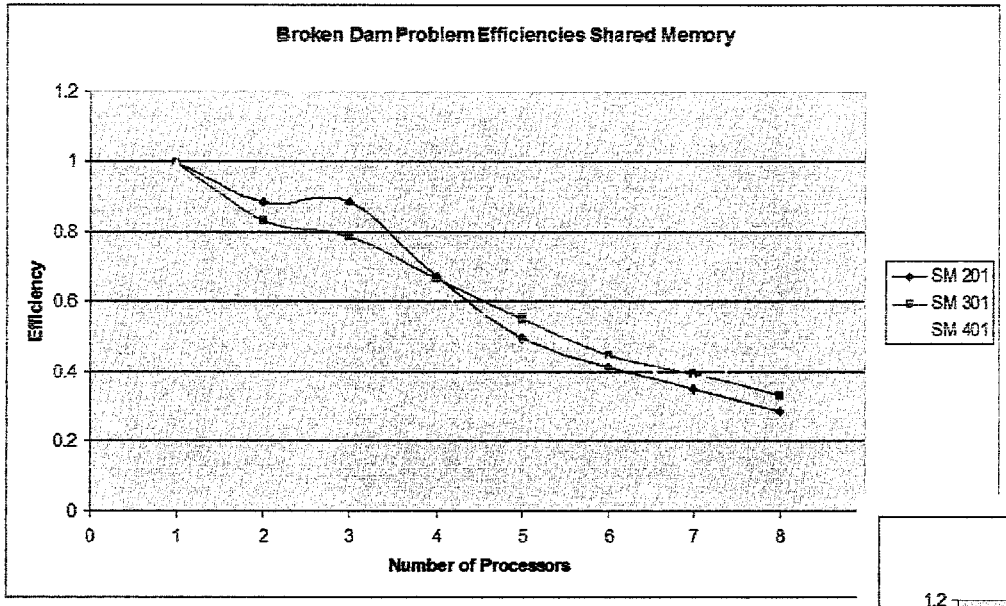
Non-reflecting



Compressible Rayleigh-Taylor Flow with Interface Tracking

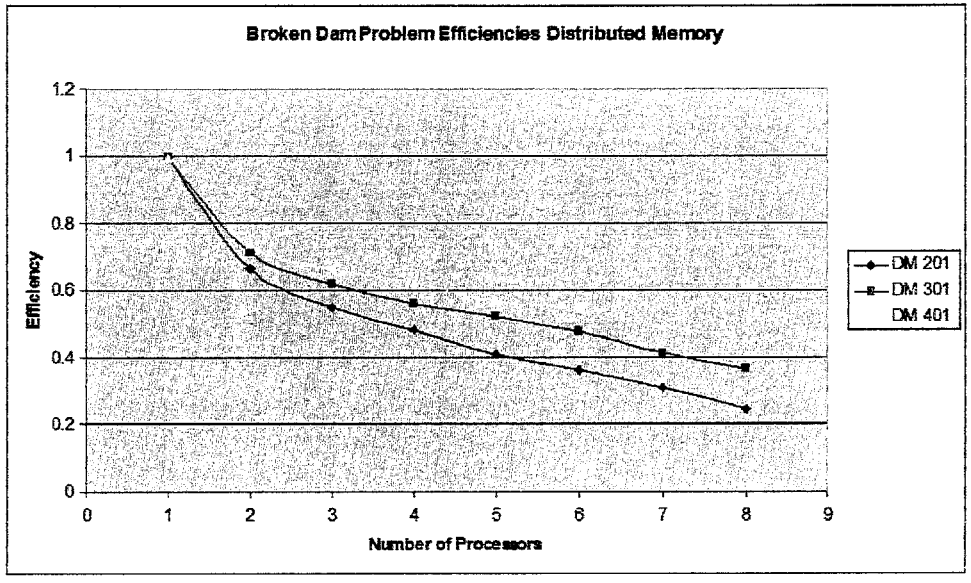


Scaling – Broken Dam Problem



Shared Memory

Distributed Memory with JavaParty



Conclusions

- CB effectively combines NK and OO Java.
- In-function left preconditioning for inter-field preconditioning effective and convenient.
- Non-equilibrium phase changing multiphase flow demonstrated.